University of California, Berkeley
Physics H7C Fall 1999 (*Strovink*)

PROBLEM SET 12

1.
Rohlf 12.5.

2.
N electrons each of mass m are confined within a (formerly) cubic infinite potential well that has been "squashed" almost flat: $V = 0$ for $(0 < x < L$ and $0 < y < L$ and $0 < z < \epsilon L)$, $V = \infty$ otherwise. Here $\epsilon \ll 1$ (cube is "squashed" in the z direction) and $N \gg 1$. The electrons do not interact with each other and are at very low temperature so that they fill up the available states in order of increasing energy. Take $\epsilon N \ll 1$, so that the z part of each electron's wavefunction may be assumed to be the same (lowest possible k_z). Thus the problem is *reduced to two dimensions*. Calculate the difference Δ between the energy of the most energetic electron (Fermi energy) and the energy of a ground state electron, using the approximation $N \gg 1$. Δ should depend on m, N, and L, but not ϵ.

3.
Write an integral equation for the fraction $\mathcal{F}$ of nonrelativistic fermions in a gas at *finite* temperature T which have energy *above* the Fermi energy E_F. The density of states is proportional to $E^{1/2}$ and the probability that a state is occupied is

$$\frac{1}{\exp\big(\beta(E - E_F)\big) + 1}$$

where $\beta = (kT)^{-1}$. You don't need to perform the integration, but you should set up the integral so that doing it would yield the correct answer without any additional physical reasoning.

4.
Rohlf 12.16.

5.
Rohlf 17.27.

6.
Rohlf 18.11.

7.
Rohlf 19.18.

8.
Rohlf 19.29.